*HPB*, 2006; 8: 432–441

Taylor & Francis
Taylor & Francis Group

**REVIEW ARTICLE**

# Pancreatic pseudocysts – when and how to treat?

ALEXANDER A. AGHDASSI[1], JULIA MAYERLE[1], MATTHIAS KRAFT[1], ANDREAS W. SIELENKÄMPER[2], CLAUS-DIETER HEIDECKE[3] & MARKUS M. LERCH[1]

[1]*Department of Gastroenterology, Endocrinology and Nutrition, Ernst-Moritz-Arndt Universität Greifswald,* [2]*Department of Anesthesiology and Intensive Care Medicine, Westfälische Wilhelms-Universität Münster and* [3]*Department of Surgery, Ernst-Moritz-Arndt Universität Greifswald, Germany*

**Abstract**

Pancreatic pseudocysts are a well-known complication of acute or chronic pancreatitis, with a higher incidence in the latter. Currently several classification systems are in use that are based on the origin of the pseudocyst, their relation to pancreatic duct anatomy and a possible pseudocyst–duct communication. Diagnosis is accomplished most often by CT scanning, by endoscopic retrograde cholangiopancreaticography (ERCP) or by ultrasound, and rapid progress in the improvement of diagnostic tools has enabled detection with high sensitivity and specificity. There are different therapeutic strategies: endoscopic transpapillary or transmural drainage, percutaneous catheter drainage, or open surgery. The feasibility of endoscopic drainage is highly dependent on the anatomy and topography of the pseudocyst, but provides high success and low complication rates. Percutaneous drainage is used for infected pseudocysts. However, its usefulness in chronic pancreatitis-associated pseudocysts is questionable. Internal drainage and pseudocyst resection are frequently used as surgical approaches with a good overall outcome, but a somewhat higher morbidity and mortality compared with endoscopic intervention. We therefore conclude that pseudocyst treatment in chronic pancreatitis can be effectively achieved by both endoscopic and surgical means.

## Introduction

Pancreatic pseudocysts belong to a large and heterogeneous group of cystic pancreatic lesions and represent a complication of acute or chronic pancreatitis. Due to progress in sensitivity and more widespread availability of diagnostic imaging techniques, the incidence of pancreatic pseudocysts seems to be increasing steadily. The development of new interventional options for the diagnosis and treatment of pancreatic pseudocysts allows for different approaches to the disease.

## Review criteria

This review entails publications referring to the classification of pancreatic pseudocysts, epidemiology and diagnostic tools, as well as therapeutic options for pancreatic pseudocysts. Only full papers were considered for the review. Based on a search in PubMed the MeSH terms 'pancreatic pseudocysts and classification', 'diagnosis' and 'endoscopic, percutaneous and surgical treatment' were used, either alone or in combination.

## Classification

From a histopathological viewpoint, pancreatic pseudocysts can be described as fluid-filled cavities arising from the pancreas and surrounded by a wall of fibrous or inflammatory tissue, but lacking an epithelial cover [1]. The cyst can be filled with pancreatic juice containing amylase, lipase and zymogens or, if no communication with the pancreatic ducts exists, with protease-free serous fluid.

Several classification systems of pancreatic pseudocysts have been proposed addressing either the pathogenesis of pseudocyst formation, as in the Atlanta classification, or morphological features such as pancreatic duct anatomy and communication of the pseudocyst with the ducts. The latter are less

Correspondence: Markus M. Lerch, MD, FRCP, Professor and Chair, Department of Gastroenterology, Endocrinology and Nutrition, Ernst-Moritz-Arndt Universität Greifswald, Friedrich-Loeffler-Str. 23A, D-17487 Greifswald, Germany. Tel: +49 03834 867230. Fax: +49 03834 867234. E-mail: lerch@uni-greifswald.de

ISSN 1365-182X print/ISSN 1477-2574 online 
DOI: 10.1080/13651820600748012

frequently used. The Atlanta classification system [2] subdivides four entities: a) acute fluid collection, occurring early in the course of acute pancreatitis and lacking a wall of granulomatous or fibrous tissue; b) acute pseudocysts, a cavity surrounded by fibrous or granulomatous tissue that is a consequence of acute pancreatitis or trauma; c) chronic pseudocysts, arising in chronic pancreatitis and without a preceding episode of acute pancreatitis; and d) pancreatic abscess, an intra-abdominal collection of pus in the proximity of the pancreas with little or no necrosis resulting from acute or chronic pancreatitis or trauma. The diagnosis of an acute pseudocyst can be made if an acute fluid collection persists for 4–6 weeks and is enveloped by a distinct wall [3]. Another classification system offered by D'Egidio and Schein in 1991 [4] is also based on the underlying disease (acute, acute-on-chronic or chronic pancreatitis), but takes the duct anatomy (normal, diseased, strictured) and the pseudocyst–duct communication (rare, sometimes, always) into account.

Nealon and Walser [5] classified pancreatic pseudocysts according to the duct anatomy and the presence or absence of communication with the pseudocyst cavity. The aim of this classification system was to propose guidelines for an appropriate treatment of pancreatic pseudocysts.

## Epidemiology

The incidence of pseudocysts in both acute and chronic pancreatitis has been assessed in large series of clinical studies. The relative proportion of acute and chronic pseudocysts varies between reports and depends on how pancreatic pseudocysts are defined and by what means they are detected [6–8]. The incidence of pseudocysts ranges from 5% to 16% in acute pancreatitis [9–11], whereas in chronic pancreatitis the numbers are higher and incidence rates of 20–40% have been published even in cohorts where advanced imaging techniques were not employed [12–14].

The highest incidence of pancreatic pseudocysts can be found in patients with chronic pancreatitis due to alcohol abuse. In a study of 97 patients with pseudocysts, alcohol consumption was found to be the causative factor in 64% of patients with chronic pancreatitis and in 26% of patients with acute pancreatitis [15].

Other studies also revealed alcohol-related pancreatitis preceding pancreatic pseudocysts in about 56–78% of patients [7,16–19]. Besides this, as far as aetiology of pancreatitis is concerned 6–36% of pseudocysts arise in gallstone-induced pancreatitis, 3–8% in post-surgical or traumatic pancreatitis, rarely after hyperlipidaemia-induced pancreatitis and in 6–20% no cause is found (idiopathic pancreatitis).

## Diagnostic techniques

A variety of diagnostic tools including CT scanning, transcutaneous and endoscopic ultrasound, ERCP and cyst aspiration, chemistry and cytology are used for the diagnostics of pancreatic pseudocysts. According to the Atlanta classification a pseudocyst is characterized by presence of a defined wall of fibrous or granulomatous tissue whereas the acute fluid collection lacks that boundary. However, a late pancreatic necrosis may also have a partly organized encapsulated morphology and differentiation becomes more difficult [20]. On CT imaging the capsule or wall of a pseudocyst shows evidence of contrast enhancement. A necrosis, particularly an infected one, can be presumed by non-enhancing zones or a heterogeneous pancreas seen on CT. However, the final diagnosis should correlate with the clinical condition of the patient [21].

In conclusion, employing imaging techniques, pseudocyst characteristics like size, location, wall thickness and septa can be detected. However, approximately 10% of pancreatic pseudocysts can have ill-defined features that overlap with the characteristics of cystic tumours [22,23].

### *Transabdominal ultrasonography*

As transabdominal ultrasonography is a very inexpensive and non-invasive technique it should be performed as a first step in the diagnosis of pancreatic pseudocysts. Taking into account that the gland can only be visualized in 80% of patients and that the technique is highly dependent on the experience of the examiner, the diagnostic sensitivity of 88–100% and the specificity of 92–98% are still high. Nevertheless, the negative predictive value (NPV) has been calculated with only 9%, which makes transabdominal ultrasound a poor tool to exclude small pancreatic pseudocysts. If interventional treatment is to be attempted, the use of a colour Doppler ultrasound, visualizing blood vessels, greatly increases the safety of the procedure [24].

### *Endoscopic ultrasound (EUS)*

Since pancreatic cystic lesions are pathologically a heterogeneous group, high-resolution EUS imaging helps to detect the majority of cystic lesions and, for small lesions $<2$ cm in diameter, EUS appears to be of particular high diagnostic sensitivity [25,26]. Endoscopic ultrasound was reported to be superior to CT regarding small lesions ($<2$ cm in diameter) because of better spatial resolution [24]. There has been some discussion about higher sensitivity of EUS in identification of debris within a pseudocyst [27] but literature regarding solid material within a cyst is not sufficient to give a final answer on that issue yet. Whether EUS-guided fine-needle aspiration (FNA) is

clearly helpful for distinguishing between benign or malignant cystic lesion is not clear yet, as the success rate and sensitivity of this technique vary greatly in different studies. Data from 123 patients with pancreatic cystic lesions of unknown origin indicated that the combination of EUS with FNA allowed for the correct diagnosis in 97%, whereas EUS alone yielded only 73% correct diagnoses [28]. A second study on 96 patients compared data from EUS-FNA with the results based on surgery and histology. The sensitivity of FNA was calculated with only 50% in patients with a cystic pancreatic lesion [29]. The Cooperative Pancreatic Cyst Study in 2004 reported 341 patients with cystic lesions $>1$ cm on EUS. They performed EUS+FNA with CEA, CA 72-4, CA 125, CA 19-9, CA 15-3, as well as cytology. The major finding of this large multicentre study in favour of FNA is that when CEA is found to be $>192$ ng/ml in the cystic fluid, a malignant pancreatic lesion can be assumed with a sensitivity of 73% and a specificity of 84% ($p<0.001$) [23].

*CT scanning*

There is a consensus that CT scanning is mandatory for planning the therapy of a pancreatic pseudocyst and CT imaging yields the highest sensitivity (82–100%) and specificity (98%, NPV: 92–94%) and an overall accuracy of 88–94% [7,30–32]. Pseudocysts mostly appear as round, fluid-filled cavities surrounded by a dense wall. CT scans should also be reviewed for location and thickness of wall, internal architecture of pseudocysts, probable necrotic debris and relation of pseudocysts to arterial vessels, as the proximity to arteries may influence the therapeutic strategy [22,30,33].

*Endoscopic retrograde cholangiopancreaticography*

Endoscopic retrograde cholangiopancreaticography (ERCP) is of major importance regarding the management of pseudocysts not only as a diagnostic tool, but also for endoscopic therapy. Although ERCP provides less information regarding the size and surrounding visceral structures than CT and ultrasound, it provides important information on the anatomy of the pancreatic and biliary ductal system and helps categorize pancreatic pseudocysts according to the classification systems by Nealon and Walser [5] or D'Egidio and Schein [4]. Communication of pancreatic pseudocysts with the pancreatic duct can be identified in 40–69% and this suggests therapy by transpapillary drainage. It is noteworthy that in the case of a suspected pancreatic pseudocyst with a communication to the pancreatic duct system, antibiotic prophylaxis before the examination is required to prevent secondary infection of the cystic lesion. Studies have demonstrated that 62–80% of patients show retrograde filling of the pseudocyst with contrast material proving the presence of a duct–pseudocyst communication [16,34,35]. Common bile duct stricture is a frequent complication in chronic pancreatitis with a reported incidence of 3–23% and sometimes caused by a pancreatic pseudocyst in the head of the organ. Nealon et al. [36] have shown that, as a result of ERCP findings, the initially planned operative strategy was altered in 24 of 41 patients (22 of 26 chronic pancreatitis patients). Evaluating the pancreatogram of 24 patients, originally classified as acute pancreatitis, ERCP even led to a change in diagnosis in 9 patients and patients were classified as suffering from chronic pancreatitis instead. Even more impressively, Laxson et al. [16] reported that ERCP changed the surgical management in 8 of 25 patients (32%).

*Magnetic resonance cholangiopancreatography*

The sensitivity of magnetic resonance cholangiopancreatography (MRCP) varies between 70% and 92% if ERCP is used as the gold standard. The fact that MRCP has a lower complication rate than ERCP and is less investigator-dependent than ultrasound will lead to its increased use as a diagnostic procedure for chronic pancreatitis in spite of its cost and its inherent lack of therapeutic options [37,38]. A diagnosis of pseudocyst–pancreatic duct communication is rather difficult, as a communication can only be identified by MRCP if a high intensity fluid tract can be detected between the pseudocyst and the duct. In this respect ERCP was found to be superior to MRCP [39]. Further developments in MRI technology will certainly improve the chances of MRCP for replacing more invasive diagnostic procedures.

## Treatment

Pancreatic pseudocysts show a wide variety of clinical presentations ranging from completely asymptomatic lesions to multiple pseudocysts with pancreatic and bile duct obstruction. The latter may require immediate endoscopic or surgical intervention to prevent secondary complications. Indications for immediate or elective interventions are summarized in Table I [2,40]. The management of pseudocysts also depends on the aetiology. Cystic pancreatic lesions, arising after an episode of acute pancreatitis, may resolve without treatment over a period of 4–6 weeks, whereas in chronic pancreatitis spontaneous pseudocyst resolution occurs rarely as maturation of the cyst wall is already complete [41,42]. The probability of spontaneous resolution ranges widely from 8% to 85% [43], depending on the aetiology, the localization and, predominantly, the size.

According to Warshaw and Rattner, a pseudocyst is unlikely to resolve spontaneously if: a) it persists for more than 6 weeks, b) chronic pancreatitis is evident, c) there is a pancreatic duct anomaly (except for a

Table I. Indications for therapeutic intervention of pancreatic pseudocysts.

| Complicated pancreatic pseudocysts (one criterion sufficient) |
|---|
| • Compression of large vessels (clinical symptoms or seen on CT scan) |
| • Gastric or duodenal outlet obstruction |
| • Stenosis of the common bile duct due to compression |
| • Infected pancreatic pseudocysts |
| • Haemorrhage into pancreatic pseudocyst |
| • Pancreatico-pleural fistula |
| Symptomatic pancreatic pseudocyst |
| • Satiety |
| • Nausea and vomiting |
| • Pain |
| • Upper gastrointestinal bleeding (10–20%) |
| Asymptomatic pancreatic pseudocyst: |
| • Pseudocysts >5 cm, unchanged in size and morphology for more than 6 weeks [2] |
| • Diameter >4 cm and extrapancreatic complications in patients with chronic alcoholic pancreatitis [40] |
| • Suspected malignancy: median 5-year survival rate after resection 56% [57] |

Table II. Prerequisites for endoscopic drainage.

| Prerequisites for endoscopic drainage |
|---|
| • Distance of pseudocyst to the gastrointestinal wall <1 cm [42,44,46] |
| • Location of transmural approach based on maximal bulge of the pseudocyst to the adjacent wall [46,47] |
| • Size >5 cm, gut compression, single cyst, mature cyst, no disconnected segment of pancreatic duct [22] |
| • Mature cyst, perform pancreatography first, prefer transpapillary approach, if feasible [27] |
| • Check for debris within pseudocyst [27] |
| • Symptomatic, failure with conservative treatment, persistence over 4 weeks or longer [45] |
| • Neoplasm and pseudoaneurysm have to be ruled out [42] |

communication with the pseudocyst) or d) the pseudocyst is surrounded by a thick wall [43]. Studying 92 patients with chronic alcoholic pancreatitis, Gouyon and co-workers reported a spontaneous regression rate of 25.7%. However, pseudocysts >4 cm and those localized extrapancreatically were found to represent predictive factors for persistent symptoms and/or complications [40].

### *Endoscopic drainage*

The aim of endoscopic treatment is to create a connection between the pseudocyst cavity and the gastrointestinal lumen. There are various methods for carrying out an endoscopic drainage and it can be accomplished by either a transpapillary or a transmural approach; the latter requires access through the stomach (cystogastrostomy) or the duodenum (cystoduodenostomy) [44,45]. Pseudocysts should have a mature capsule (wall thickness >3 mm and <1 cm), impress the stomach wall and have a minimum size of 5–6 cm to become eligible for endoscopic drainage [22,27]. Proposed guidelines are shown in Table II [22,27,42,44–47]. At the time of writing, it is still not clear which technique should be generally favoured. Some authors suggest that transpapillary drainage should be preferred as the morbidity is lower compared with alternative drainage methods [27,45]. The patient should also be evaluated for pseudoaneurysms and for portal hypertension as well as gastric varices to decrease the risk of haemorrhage after puncture [27].

### *Endoscopic transpapillary drainage*

If the pseudocyst communicates with the pancreatic duct, transpapillary drainage becomes the therapy of choice. Pancreatic duct sphincterotomy facilitates cannulation and a guidewire is passed through the duct directly into the pseudocyst cavity. Thereafter a plastic stent of 5–7F (but up to 10F) in diameter is pushed over the wire [44,45]. Transpapillary drainage can still be considered when the proximal pancreatic duct is obstructed by stones and strictures, but becomes less likely when pseudocyst location is in the tail of the pancreas [42]. If pseudocysts present with heterogeneous content, either necrotic or filled with debris, or an abscess is suspected, a transpapillary nasocystic catheter is inserted to allow aspiration of the pseudocysts content and rinsing of the cystic cavity with saline. Broad-spectrum antibiotics will be administered in case of infected pseudocysts [48]. The duration of stenting depends on the time course of pseudocyst regression. The length of therapy varies, with a median of 4.4 months [48]. In a study by Catalano et al., stents were routinely exchanged every 6–8 weeks as long as pseudocysts remained unresolved [49].

### *Endoscopic transmural drainage*

When the pseudocyst causes a visible impression of the gastric or duodenal wall, transmural drainage becomes a feasible option. Apposition of the cyst wall towards the stomach or small intestine is ascertained by CT scan or EUS and intraluminal bulging should be obvious on upper endoscopy [45]. Once the bulge is located, its apex can be identified for needle puncture. Following needle puncture of the pseudocyst fluid content can be aspirated (for chemical or cytological analysis) and a guidewire is inserted, along which an incision can be made using either a diathermic coagulation probe [45] or a needle-knife-papillotome [27,30]. Once access has been achieved, either a balloon [44] or a double-pigtail catheter can be passed into the cyst over the wire. Transmural stents are removed after complete resolution of the pancreatic pseudocyst, which is monitored by CT, or preferably ultrasound, performed at 4-week intervals after the initial endoscopic drainage [44].

Table III. Outcome of endoscopic drainage (cumulative data for transpapillary and transmural endoscopic drainage).

| Reference | No. of patients | Ultimate success | Complete resolution* | Recurrence rate† | Complications‡ |
|---|---|---|---|---|---|
| Binmöller et al., 1995 [45] | 53 (49 with chronic pancreatitis) | 43 (81%) | 47 (89%) | 11 (23%) | 6 (11%) |
| Smits et al., 1995 [46] | 37 (all chronic pancreatitis) | 24 (65%) | 24 (65%) | 3 (12.5%) | 6 (16%) procedure-related<br>7 (19%) related to stents or drains |
| Barthet et al., 1995 [48] | 30 (28 with chronic pancreatitis) | 23 (77%) | 26 (87%) | 3 (11.5%) | 4 (13%) |
| Baron et al., 2002 [20] | 64 (chronic pseudocysts) | 52 (81%) | 59 (92%) | 7 (12%) | 11 (17%) |
| Catalano et al., 1995 [49] | 21 (persistence of pseudocysts >6 weeks in all patients) | 16 (76%) | 17 (81%) | 1 (6%) | 1 (5%) |

*Based on number of patients who underwent endoscopy.
†Based on number of patients with complete resolution.
‡Based on total number of patients.

Success rates for endoscopic treatment are outlined in Table III and are taken from studies on patients with mainly chronic pancreatitis or with pseudocysts that persisted for >6 weeks. Technical feasibility rates of endoscopic transpapillary and transmural drainage are between 92% and 100% [45,46,49]. Reasons for failure are: no clear impression of the pseudocyst into the lumen of the stomach or gut, failed insertion of the drain, bleeding and gallbladder puncture. Binmoeller et al. and Catalano et al. could show successful transpapillary endoprosthesis placement in all cases [45,49]. Long-term success of pseudocyst drainage is rated from 65% up to 81%, but the initial success is likely to be higher, because recurrence of pseudocysts occurs in up to 23%. In a series of 50 patients with initial endoscopic drainage, pseudocysts resolved completely in 47 patients (94%) after a mean period of 3.6 months. Recurrence of pseudocysts was observed in 11 patients after a mean observation period of 11 months, of whom 5 had been treated by transpapillary and 6 by transmural drainage [45]. None of the approaches – transpapillary, transgastric or transduodenal drainage – were predictive of recurrence [20].

Complications are related either directly to the procedure or can occur in relation to stents and drains. Bleeding is one of the most serious complications in endoscopic drainage, as variceal or arterial bleeding due to penetration of the gastric or duodenal wall can occur, requiring sclerotherapy or emergency surgery. Complications of transpapillary drainage are closely related to those of ERCP and include pancreatitis, risk of bacteraemia or sepsis and abscess formation. Stent-related complications imply dislocation and clogging with subsequent infection. Pigtail stents may be inferior in drainage capacity to straight stents but the risk of migration is lower [20,49].

Endoscopic drainage seems to be an effective tool in treating pancreatic pseudocysts, with final success rates of >80%. Recurrence of pseudocysts or complications may require endoscopic re-treatment. There are also encouraging data on drainage using the Seldinger technique in pancreatic fluid collections that can reduce the risk of bleeding and accidental perforation [47]. In conclusion, if technically feasible, endoscopic drainage should be the method of choice to treat large pancreatic pseudocysts.

### *Percutaneous drainage*

Percutaneous drainage involves either simple percutaneous aspiration or percutaneous catheter placement, most commonly performed under CT control, but in some cases under sonographic or fluoroscopic guidance. It is a valuable alternative to operative management, as maturation of the pseudocyst wall does not have to be awaited. Further indications are symptomatic, expanding immature cysts and patients with infected pseudocysts [3,25]. Drainage can be performed via a 7–12F pigtail catheter that is inserted into the pseudocyst via needle-inserted guidewires or alternatively by using a trocar (Figure 1). Possible routes for percutaneous pseudocyst drainage are transperitoneal, retroperitoneal, transgastric, transhepatic and transduodenal approaches [3,6,50,51].

Continuous percutaneous drainage is reported to show a failure rate of 16%, a recurrence rate of 7% and a complication rate of 18% [3]; however, most series do not distinguish between acute and chronic pseudocysts.

The use of percutaneous drainage on patients with chronic pancreatitis is rather questionable. Nealon and Walser predicted the outcome of percutaneous drainage to be dependent on the pancreatic duct anatomy: most favourable results were obtained in patients with normal ductal anatomy or ductal stricture without communication to the pseudocyst. Patients with chronic pancreatitis were found to be ineligible [5]. D'Egidio and Schein [4] divided a total of 78 patients into 3 groups: post-necrotic pseudocysts associated with acute pancreatitis (group I); post-necrotic pseudocysts associated with acute

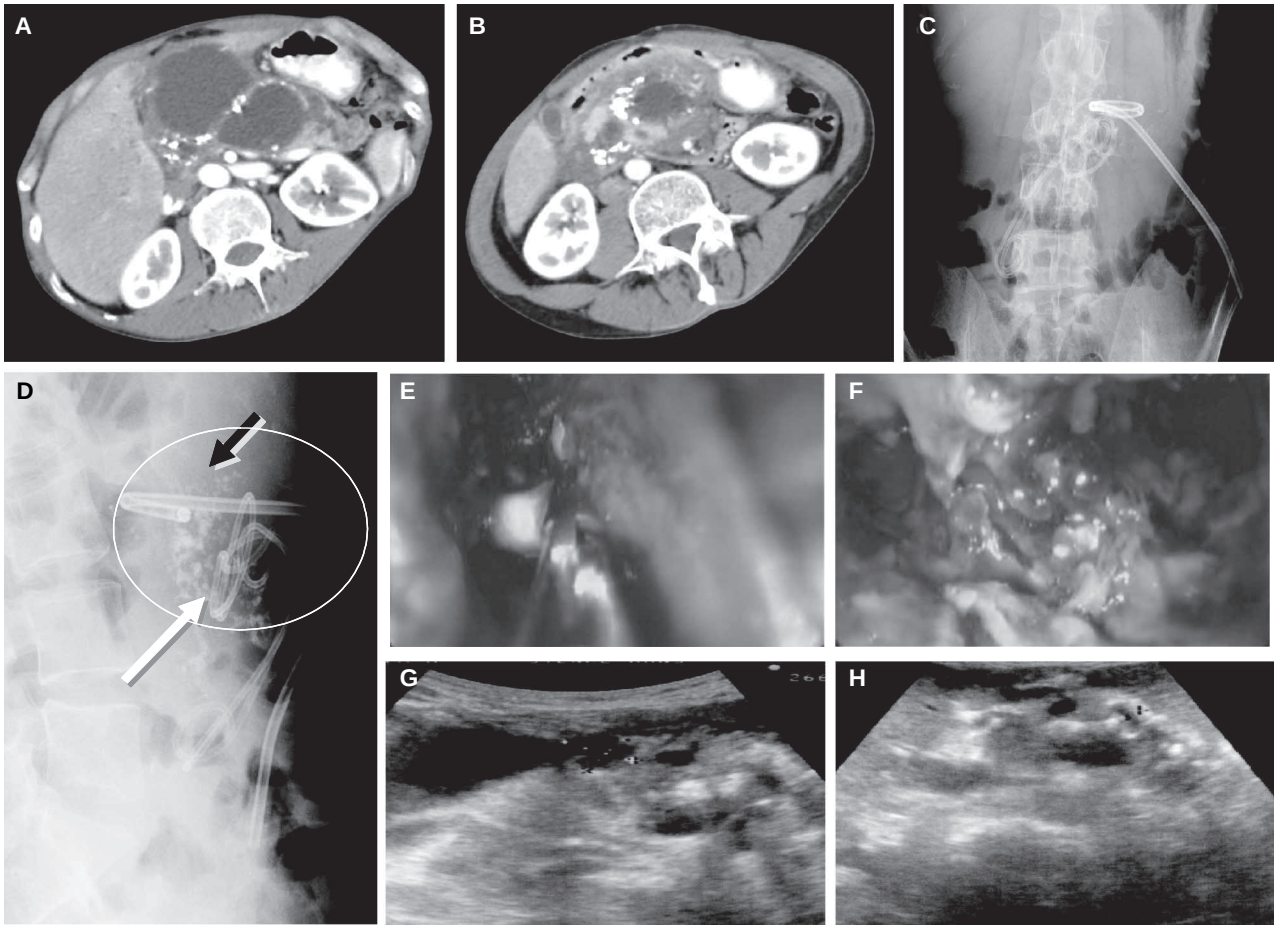


Figure 1. A 42-year-old man presented with an acute episode of alcoholic chronic pancreatitis. During the course of the disease he developed an infected pancreatic pseudocyst as shown on the CT scan (A and B). To achieve rapid drainage a percutaneous CT-guided catheter was inserted (C, plain radiograph), but this did not lead to resolution of the cyst. In a second step a pigtail catheter was inserted via puncture of the duodenal wall (D, plain radiograph). The pigtail catheter spontaneously dislocated into the cyst. By needle knife incision from the duodenum into the cyst we recovered the dislocated stent and endoscopically cleared and rinsed the cystic cavity every other day (E and F). The patient was discharged without any further complications 8 days after the salvage of the pigtail catheter. Three months later transabdominal ultrasound examination revealed a small residual cyst (G), as well as a dialated pancreatic duct (H) but no further complication.

pancreatitis, superimposed on chronic pancreatitis (group II); and retention pseudocysts based on chronic pancreatitis (group III). According to that classification, percutaneous drainage was highly effective in patients with acute pancreatitis and to a lesser degree in group II patients who needed prolonged drainage. If drainage persists for longer than 6–7 weeks, it should be considered to have failed. Nevertheless, at the time when D'Egidio et al. conducted their study, the frequent use of EUS-guided endoscopic drainage of pancreatic pseudocysts was not an option and this has to be taken into account when the results are evaluated. In patients with retention pseudocysts after chronic pancreatitis (group III) percutaneous drainage was not effective. However, for infected pancreatic pseudocysts that require immediate treatment percutaneous drainage was shown to be applicable with success rates of 94–96% and a mean drainage time of 16.7 or 26.5 days [50,51].

Complications include catheter-related secondary infections, catheter occlusion, cellulitis at the site of entry and sepsis [3].

## Surgery

Despite recent developments in minimally invasive techniques and further progress in CT- and ultrasound-guided therapy, surgical drainage is still a principal method in the management of pancreatic pseudocysts. It traditionally includes internal and external drainage and excision. A surgical approach can be indicated in patients with: a) complicated pseudocysts, i.e. infected and necrotic pseudocysts; b) pseudocysts associated with pancreatic duct stricture and a dilated pancreatic duct; c) suspected cystic neoplasia; d) coexistence of pseudocysts and bile duct stenosis; and e) complications such as compression of the stomach or the duodenum, perforation and haemorrhage due to erosion of arteries or

pseudoaneurysms [52]. Timing of surgical intervention depends on maturation of the cyst wall. In chronic pancreatitis pseudocysts can be treated without any delay under the assumption that maturation of the cyst wall has already taken place and can thus withstand sutures, whereas optimal timing in acute or traumatic pseudocysts is more difficult [6,43].

*Surgical internal drainage*

Internal drainage is the method of choice for uncomplicated mature pseudocysts. Depending on the topographic anatomy, pseudocystogastrostomy is done for cysts directly adherent to the posterior wall of the stomach. Small (<4 cm) pseudocysts in the head and the uncinate process of the pancreas are eligible for pseudocystoduodenostomy and pseudocystojejunostomy can be performed for all other cysts including extremely large (>15 cm) cysts [3,42]. There is controversy as to whether pseudocystogastrostomy and pseudocystoduodenostomy are equivalent in their outcome: pseudocystogastrostomy has been reported to be simple, quick and less prone to infections, but tends to be associated with more frequent upper gastrointestinal bleedings. Pseudocystojejunostomy seems to be more popular and results are somewhat better than for pseudocystogastrostomy [42]. Newell et al. [53] found no significant difference in cyst recurrence, morbidity or mortality between cystogastrostomy and cystojejunostomy but the duration of the operation and blood loss were less after cystogastrostomy.

*Pseudocyst resection*

Resection is an alternative procedure to internal drainage for chronic pseudocysts and indications include painful chronic pancreatitis, multiple cysts, gastrointestinal haemorrhage from pseudoaneurysm, common bile duct or duodenal obstruction and technical inability to drain pseudocysts located in the uncinate process [6]. Resection is performed by different operation methods including partial left-sided pancreatectomy preserving the spleen if possible, or by partial right-sided pancreatectomy (Whipple's procedure, pylorus-preserving pancreatoduodenectomy, Beger's operation or Frey's procedure) [42].

*Laparoscopic surgery*

Due to continuing progress in laparoscopic techniques minimally invasive surgery offers new modalities in the treatment of pancreatic pseudocysts. Although laparoscopic pseudocystogastrostomy and pseudocystojejunostomy result in adequate internal drainage and minimal morbidity, experience is limited and long-term outcome of relevant studies is awaited [54].

*External drainage*

External drainage is indicated for immature cysts with infected contents and for ruptured cysts. It hardly ever applies to patients with chronic pancreatitis unless the pancreatic cyst has developed after a superimposed attack of necrotizing pancreatitis [3,42].

## Comparison of surgical and percutaneous treatment modalities

Both, operative and non-operative management are effective means for the resolution of pancreatic pseudocysts, as shown in various studies. In a work done by Usatoff et al. [17] 112 patients with confirmed chronic pancreatitis underwent open operation, either by drainage, resection or a combination of both. The morbidity rate was 28% and the mortality rate was 1%. In 74% of patients pain was relieved and pseudocyst recurrence rate was 3%. Those data are compatible with cumulative data showing success rates from 70% to 100%, morbidity of 9–36% and a mortality of between 0% and 8%. Cyst recurrence was observed in 0–30% of the patients [42].

Compared with surgery, percutaneous cyst drainage avoids a major operation, but outcome and complication rates vary between studies. According to Adams and Anderson pseudocysts can be managed effectively by operation or percutaneous drainage and no significant difference in direct complications and subsequent operations due to complications was evident [55]. On the other hand, percutaneous drainage was associated with a higher failure rate and the initial success rate was only 42% compared with 88% after surgery. Morbidity and mortality were increased in patients who underwent percutaneous drainage in another study [56]. Percutaneous drainage is a useful tool for immature or infected cysts after acute pancreatitis, but it is of limited use and treatment benefit for pseudocysts related to chronic pancreatitis. In addition, recurrence rates are high and fistulas may form.

So far there are no studies available that directly compared success rates, morbidity and mortality of endoscopic therapy versus surgical intervention. Some studies favour the endoscopic approach as it is less invasive and is associated mostly with a shorter hospital stay, lower morbidity and lower mortality. However, one has to take into account that only selected patients can be managed endoscopically and surgical patients tend to be more critically ill.

A clinical algorithm which is used at the University of Greifswald depends on size and localization of the cyst and the occurrence of secondary complications (Figure 2). Diagnosis is assessed by means of both CT scan and EUS. In case of a small cyst (<5 cm) or the absence of secondary complications the strategy is to wait and observe. If size exceeds 5 cm and/or

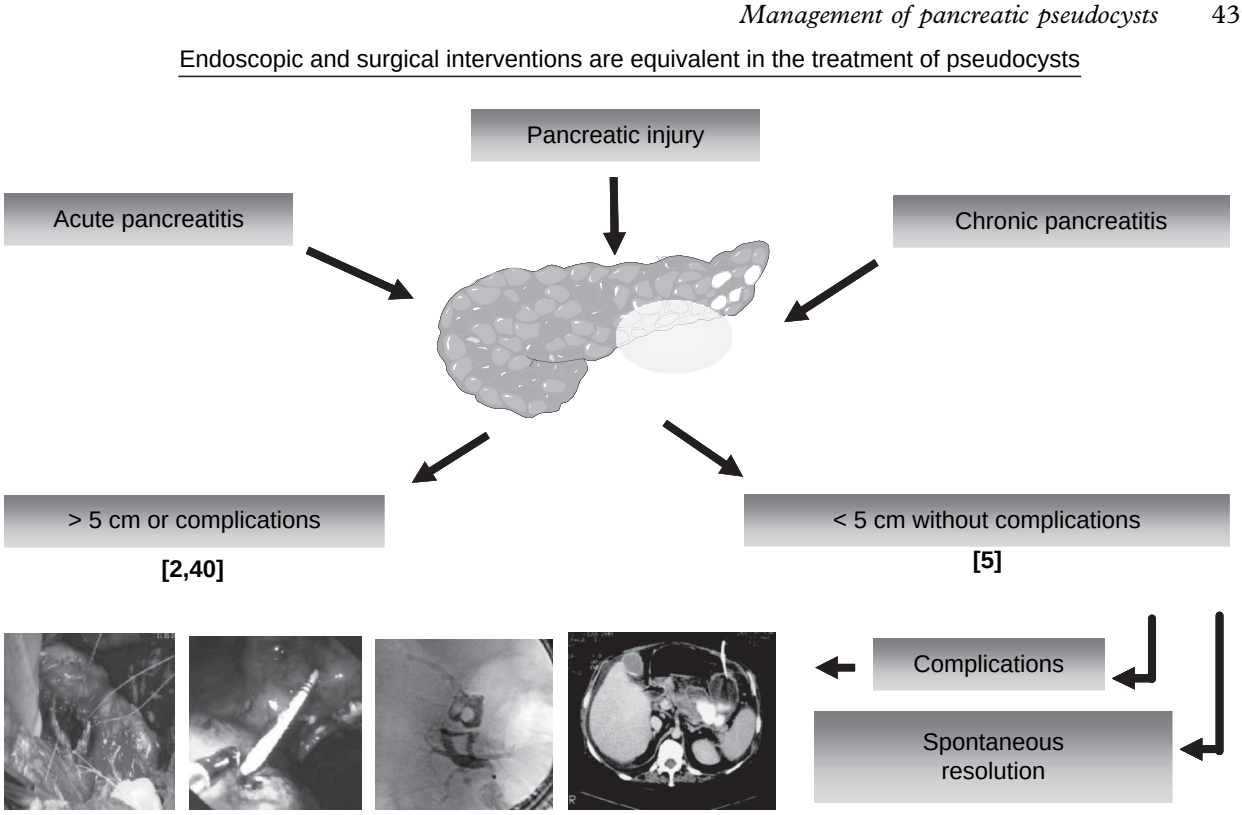


Figure 2. Clinical algorithm used at the University of Greifswald for the treatment of pancreatic pseudocysts. Pancreatic pseudocysts result from acute pancreatitis, chronic pancreatitis or pancreatic injury. The primary decision for or against treatment of pancreatic pseudocysts depends on size and localization of the cyst and the occurrence of secondary complications. In case of a small cyst ( $<5$ cm) or absent secondary complications the strategy is to wait and observe. If size exceeds 5 cm and/or complications occur the cyst can be treated either surgically or endoscopically with equal outcome.

complications occur the cyst can be treated either surgically or endoscopically with equivalent outcome.

## Conclusions

Pancreatic pseudocysts are a known complication of acute and chronic pancreatitis. Chronic pseudocysts over 8 weeks are less likely to resolve spontaneously and, as the risk of complications increases with time, treatment of large pseudocysts ( $>5$ cm) should not be postponed [6]. Introduction of new and sensitive imaging techniques permits the detection of more pancreatic cystic lesions with better evaluation of adjacent structures. Exact classification of pseudocysts is an important factor for both the determination of the actual number of pseudocysts and the implementation of therapeutic strategies.

Surgery is the traditional modality for treating pancreatic pseudocysts, with high success rates and low morbidity and mortality, and it still plays an important role in therapy. Laparoscopic management has been reported with very encouraging results, but long-term follow-up has still to show equivalence to open surgery. Endoscopic therapy is a reasonable alternative to surgery, particularly for chronic pseudocysts, displaying an even lower morbidity and mortality rate. Failure of transpapillary or transmural drainage may make subsequent surgery necessary [42]. Nonetheless, initial endoscopic drainage should be considered as a valuable tool and the method of choice in patients with chronic pancreatitis-associated large pseudocysts [56].

## References

[1] Kloppel G. Pseudocysts and other non-neoplastic cysts of the pancreas. Semin Diagn Pathol 2000;17:7–15.
[2] Bradley EL 3rd. A clinically based classification system for acute pancreatitis. Summary of the International Symposium on Acute Pancreatitis, Atlanta, Ga, September 11 through 13, 1992. Arch Surg 1993;128:586–90.
[3] Pitchumoni CS, Agarwal N. Pancreatic pseudocysts. When and how should drainage be performed? Gastroenterol Clin North Am 1999;28:615–39.
[4] D'Egidio A, Schein M. Pancreatic pseudocysts: a proposed classification and its management implications. Br J Surg 1991;78:981–4.
[5] Nealon WH, Walser E. Main pancreatic ductal anatomy can direct choice of modality for treating pancreatic pseudocysts (surgery versus percutaneous drainage). Ann Surg 2002;235:751–8.
[6] Grace PA, Williamson RC. Modern management of pancreatic pseudocysts. Br J Surg 1993;80:573–81.
[7] O'Malley VP, Cannon JP, Postier RG. Pancreatic pseudocysts: cause, therapy, and results. Am J Surg 1985;150:680–2.
[8] Sankaran S, Walt SJ. The natural and unnatural history of pancreatic pseudocysts. Br J Surg 1975;62:37–44.
[9] Bradley EL, Gonzalez AC, Clements JL Jr. Acute pancreatic pseudocysts: incidence and implications. Ann Surg 1976;184:734–7.

[10] Maringhini A, Uomo G, Patti R, Rabitti P, Termini A, Cavallera A, et al. Pseudocysts in acute nonalcoholic pancreatitis: incidence and natural history. Dig Dis Sci 1999;44: 1669–73.
[11] London NJ, Neoptolemos JP, Lavelle J, Bailey I, James D. Serial computed tomography scanning in acute pancreatitis: a prospective study. Gut 1989;30:397–403.
[12] Barthet M, Bugallo M, Moreira LS, Bastid C, Sastre B, Sahel J. Management of cysts and pseudocysts complicating chronic pancreatitis. A retrospective study of 143 patients. Gastroenterol Clin Biol 1993;17:270–6.
[13] Ammann RW, Akovbiantz A, Largiader F, Schueler G. Course and outcome of chronic pancreatitis. Longitudinal study of a mixed medical-surgical series of 245 patients. Gastroenterology 1984;86(5 Pt 1):820–8.
[14] Elliott DW. Pancreatic pseudocysts. Surg Clin North Am 1975;55:339–62.
[15] Sanfey H, Aguilar M, Jones RS. Pseudocysts of the pancreas, a review of 97 cases. Am Surg 1994;60:661–8.
[16] Laxson LC, Fromkes JJ, Cooperman M. Endoscopic retrograde cholangiopancreatography in the management of pancreatic pseudocysts. Am J Surg 1985;150:683–6.
[17] Usatoff V, Brancatisano R, Williamson RC. Operative treatment of pseudocysts in patients with chronic pancreatitis. Br J Surg 2000;87:1494–9.
[18] Kolars JC, Allen MO, Ansel H, Silvis SE, Vennes JA. Pancreatic pseudocysts: clinical and endoscopic experience. Am J Gastroenterol 1989;84:259–64.
[19] Walt AJ, Bouwman DL, Weaver DW, Sachs RJ. The impact of technology on the management of pancreatic pseudocyst. Fifth Annual Samuel Jason Mixter Lecture. Arch Surg 1990; 125:759–63.
[20] Baron TH, Harewood GC, Morgan DE, Yates MR. Outcome differences after endoscopic drainage of pancreatic necrosis, acute pancreatic pseudocysts, and chronic pancreatic pseudocysts. Gastrointest Endosc 2002;56:7–17.
[21] Balthazar EJ, Freeny PC, vanSonnenberg E. Imaging and intervention in acute pancreatitis. Radiology 1994;193:297–306.
[22] Lehman GA. Pseudocysts. Gastrointest Endosc 1999;49(3 Pt 2):S81–S84.
[23] Brugge WR, Lewandrowski K, Lee-Lewandrowski E, Centeno BA, Szydlo T, Regan S, et al. Diagnosis of pancreatic cystic neoplasms: a report of the cooperative pancreatic cyst study. Gastroenterology 2004;126:1330–6.
[24] Polakow J, Ladny JR, Serwatka W, Walecki J, Puchalski Z, Czech B. Percutaneous fine-needle pancreatic pseudocyst puncture guided by three-dimensional sonography. Hepatogastroenterology 2001;48:1308–11.
[25] Andrén-Sandberg A, Maleckas A. Pancreatic pseudocysts. Diagnosis, treatment and results in the 2003s. A literature study aiming at evidence based surgery. 2003;262.
[26] Gress F, Gottlieb K, Cummings O, Sherman S, Lehman G. Endoscopic ultrasound characteristics of mucinous cystic neoplasms of the pancreas. Am J Gastroenterol 2000;95: 961–5.
[27] Chak A. Endosonographic-guided therapy of pancreatic pseudocysts. Gastrointest Endosc 2000;52(6 Suppl):S23–S27.
[28] Frossard JL, Amouyal P, Amouyal G, Palazzo L, Amaris J, Soldan M, et al. Performance of endosonography-guided fine needle aspiration and biopsy in the diagnosis of pancreatic cystic lesions. Am J Gastroenterol 2003;98:1516–24.
[29] Brandwein SL, Farrell JJ, Centeno BA, Brugge WR. Detection and tumor staging of malignancy in cystic, intraductal, and solid tumors of the pancreas by EUS. Gastrointest Endosc 2001;53:722–7.
[30] Hawes RH. Endoscopic management of pseudocysts. Rev Gastroenterol Disord 2003;3:135–41.
[31] Kressel HY, Margulis AR, Gooding GW, Filly RA, Moss A, Korobkin M. CT scanning and ultrasound in the evaluation of pancreatic pseudocysts: a preliminary comparison. Radiology 1978;126:153–7.
[32] Lee JK, Stanley RJ, Melson GL, Sagel SS. Pancreatic imaging by ultrasound and computed tomography: a general review. Radiol Clin North Am 1979;17:105–17.
[33] Brugge WR. Approaches to the drainage of pancreatic pseudocysts. Curr Opin Gastroenterol 2004;20:488–92.
[34] Rohrmann CA, Silvis SE, Vennes JA. Evaluation of the endoscopic pancreatogram. Radiology 1974;113:297–304.
[35] Sugawa C, Walt AJ. Endoscopic retrograde pancreatography in the surgery of pancreatic pseudocysts. Surgery 1979;86: 639–47.
[36] Nealon WH, Townsend CM Jr, Thompson JC. Preoperative endoscopic retrograde cholangiopancreatography (ERCP) in patients with pancreatic pseudocyst associated with resolving acute and chronic pancreatitis. Ann Surg 1989;209:532–8; discussion 538–40.
[37] Sica GT, Braver J, Cooney MJ, Miller FH, Chai JL, Adams DF. Comparison of endoscopic retrograde cholangiopancreatography with MR cholangiopancreatography in patients with pancreatitis. Radiology 1999;210:605–10.
[38] Jensen AR, Matzen P, Malchow-Moller A, Christofferson I. Pattern of pain, duct morphology, and pancreatic function in chronic pancreatitis. A comparative study. Scand J Gastroenterol 1984;19:334–8.
[39] Varghese JC, Masterson A, Lee MJ. Value of MR pancreatography in the evaluation of patients with chronic pancreatitis. Clin Radiol 2002;57:393–401.
[40] Gouyon B, Levy P, Ruszneiwski P, Zins M, Hammel P, Vilgrain V, et al. Predictive factors in the outcome of pseudocysts complicating alcoholic chronic pancreatitis. Gut 1997;41:821–5.
[41] Crass RA, Way LW. Acute and chronic pancreatic pseudocysts are different. Am J Surg 1981;142:660–3.
[42] Rosso E, Alexakis N, Ghaneh P, Lombard M, Smart HL, Evans J, et al. Pancreatic pseudocyst in chronic pancreatitis: endoscopic and surgical treatment. Dig Surg 2003;20:397–406.
[43] Warshaw AL, Rattner DW. Timing of surgical drainage for pancreatic pseudocyst. Clinical and chemical criteria. Ann Surg 1985;202:720–4.
[44] Monkemuller KE, Kahl S, Malfertheiner P. Endoscopic therapy of chronic pancreatitis. Dig Dis 2004;22:280–91.
[45] Binmoeller KF, Seifert H, Walter A, Soehendra N. Transpapillary and transmural drainage of pancreatic pseudocysts. Gastrointest Endosc 1995;42:219–24.
[46] Smits ME, Rauws EA, Tytgat GN, Huibregtse K. The efficacy of endoscopic treatment of pancreatic pseudocysts. Gastrointest Endosc 1995;42:202–7.
[47] Monkemuller KE, Baron TH, Morgan DE. Transmural drainage of pancreatic fluid collections without electrocautery using the Seldinger technique. Gastrointest Endosc 1998;48: 195–200.
[48] Barthet M, Sahel J, Bodiu-Bertei C, Bernard JP. Endoscopic transpapillary drainage of pancreatic pseudocysts. Gastrointest Endosc 1995;42:208–13.
[49] Catalano MF, Geenan JE, Schmalz MJ, Johnson GK, Dean RS, Hogan WJ. Treatment of pancreatic pseudocysts with ductal communication by transpapillary pancreatic duct endoprosthesis. Gastrointest Endosc 1995;42:214–8.
[50] Cantasdemir M, Kara B, Kantarci F, Mihmanli I, Numan F, Erguney S. Percutaneous drainage for treatment of infected pancreatic pseudocysts. South Med J 2003;96:136–40.
[51] vanSonnenberg E, Wittich GR, Casola G, Brannigan TC, Karnel F, Stabile BE, et al. Percutaneous drainage of infected and noninfected pancreatic pseudocysts: experience in 101 cases. Radiology 1989;170(3 Pt 1):757–61.

[52] Cooperman AM. Surgical treatment of pancreatic pseudocysts. Surg Clin North Am 2001;81:411–19, xii.

[53] Newell KA, Liu T, Aranha GV, Prinz RA. Are cystgastrostomy and cystjejunostomy equivalent operations for pancreatic pseudocysts? Surgery 1990;108:635–9; discussion 639–40.

[54] Bhattacharya D, Ammori BJ. Minimally invasive approaches to the management of pancreatic pseudocysts: review of the literature. Surg Laparosc Endosc Percutan Tech 2003;13: 141–8.

[55] Adams DB, Anderson MC. Percutaneous catheter drainage compared with internal drainage in the management of pancreatic pseudocyst. Ann Surg 1992;215:571–6; discussion 576–8.

[56] Heider R, Meyer AA, Galanko Ja, Behrns KE. Percutaneous drainage of pancreatic pseudocysts is associated with a higher failure rate than surgical treatment in unselected patients. Ann Surg 1999;229:781–7; discussion 787–9.

[57] Ridder GJ, Maschek H, Klempnauer J. Favourable prognosis of cystadeno- over adenocarcinoma of the pancreas after curative resection. Eur J Surg Oncol 1996;22:232–6.